

CLAIMS

1. A method of determining a path along some of a plurality of points in a virtual environment comprising a plurality of initially defined points, and obstructions through which
5 the path cannot pass, and in which two points are said to have line of sight if a straight line link between the two points does not pass through any of the obstructions, the method comprising:
 - (a) selecting a start point and a destination point for said path in said virtual environment;
 - 10 (b) dynamically redefining the topology of the virtual environment by generating a plurality of additional points, wherein said plurality of additional points are generated by repeating the following step:
 - defining a new point located on a line of sight link between two existing points;
 - (c) calculating the path based on any combination of new and/or initially defined
15 points between said start point and said end point.
2. A method as claimed in claim 1, wherein said step of dynamically redefining the topology of the virtual environment comprises increasing the density of the nodal mesh density between said start point and said end point compared to the density of the nodal
20 mesh prior to the selection of a start point and an end point for said path.
3. A method as claimed in claim 1 or 2, wherein said virtual environment comprises a representation of a virtual world.
- 25 4. A method according to any previous claim, wherein the new point is located on the mid point of the link.
- X5. A method according to any previous claim, further comprising in (b) the step of:
 - deleting the new point if it is less than a predefined distance from another of the
30 points.
- X6. A method according to claim 5, wherein the predefined distance varies in different regions of the virtual environment.
- 35 X7. A method according to any preceding claim, further comprising identifying a link as not being suitable for providing the location for a new point if said link intersects another one

of said links which is shorter.

8. A method according to any preceding claim, further comprising deleting a new point if it does not have line of sight to each of a pair of points which do not have line of sight to each other.

9. A method according to any of claims 1 to 8, further comprising deleting a new point if it does not form part of a path between two other nodes that is shorter than the shortest path which would exist between said two points without said new point.

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10. A method according to any preceding claim, further comprising receiving an indication from a user that they desire a path to be calculated, and wherein said step (b) occurs after said indication has been received.

11. A method according to claim 10, in which the virtual world comprises a plurality of regions each containing one or more points, and in which the step (b) is performed in relation to one or more of the regions prior to receiving said indication, and step (a) is performed in relation to other one or more of the regions after said indication has been received.

12. A method according to claim 11, in which said other one or more regions contain obstacles which move within the virtual environment.

13. A method according to claim 11 in which said other one or more regions contain a point which has been created by the user as representing the start or the destination point for said path.

14. A method according to any preceding claim further comprising defining one or more feature entities within the environment having associated regions of influence, and calculating interest values in respect of at least some of the points in dependence upon whether or not they fall within a region of influence, wherein the step of calculating the path takes into consideration the interest values.

15. A method according to claim 14 wherein the or each interest value varies in inverse dependence upon the Euclidean distance of the respective point from the centre of the respective region of influence.

16. A method of determining a route along some of a plurality of points in a representation of a real or virtual environment the method comprising:

(a) defining one or more feature entities within the environment having associated regions of influence;

5 (b) calculating interest values in respect of at least some of the points in dependence on whether or not they fall within a region of influence; and

(c) calculating the route based on the interest values calculated in step (b).

17. A method of controlling the field of view of a virtual entity travelling through a virtual
10 world, the method comprising associating with one or more other virtual entities a region of influence and generating a field of view parameter in respect of the travelling virtual entity which controls the field of view associated with the entity as it travels through the virtual world wherein the field of view parameter is calculated in a manner which depends upon whether the virtual entity is within or without a region of influence.

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18. A system for storing a representation of a virtual world, the representation comprising a plurality of initially defined points, and obstructions through which the path cannot pass, and in which two points are said to have line of sight if a straight line link between the two points does not pass through any of the obstructions, the system being arranged to
20 determine a path along some of a plurality of points in said representation by

(a) defining a plurality of additional points by repeating the following step:

defining a new point located on a line of sight link between two existing points

(b) calculating the path based on any combination of new and/or initially
25 defined points

19. A system according to claim 18, wherein the new point is located on the mid point of the link.

30 ~~20~~. A system according to claim 18 or 19, further arranged in (a) to:
delete the new point if it is less than a predefined distance from another of the points.

21. A system according to claim 20, wherein the predefined distance varies in different
35 regions of the virtual world.

- X 22. A system according to any of claims 18 to 21, further arranged to identify a link as not being suitable for providing the location for a new point if said link intersects another one of said links which is shorter.
- 5 23. A system according to any of claims 18 to 22, further arranged to delete a new point if it does not have line of sight to each of a pair of points which do not have line of sight to each other.
- X 24. A system according to any of claims 18 to 23, further arranged to delete a new point if
10 it does not form part of a path between two other nodes that is shorter than the shortest path which would exist between said two points without said new point.
25. A system according to any of claims 18 to 25, further arranged to receive an indication from a user that they desire a path to be calculated, and wherein said step (a) is
15 performed after said indication has been received.
26. A system according to claim 25, in which the virtual world comprises a plurality of regions each containing one or more points, and in the system is arranged to perform step (a) in relation to one or more of the regions prior to receiving said indication, and to perform
20 step (a) in relation to other one or more of the regions after receiving said indication.
27. A system according to claim 26 in which said other one or more regions contain obstacles which move within the virtual world.
- 25 28. A system according to claim 26 in which said other one or more regions contain a point which has been created by the user as representing a start or destination point for said path.
29. A system according to any one of claims 18 to 28 further including: storage means
30 storing a plurality of data groups, each of which stores data associated with a feature entity within the representation including data defining a region of influence associated with the feature entity; calculation means for calculating interest values in respect of at least some of the points in dependence upon whether or not they fall within a region of influence; and processing means for generating a route along a plurality of the points in dependence upon
35 the interest values.

30. Apparatus for generating a route along a plurality of nodes in a representation of a real or virtual environment, the apparatus comprising:

- 5 (a) storage means storing a plurality of data groups, each of which stores data associated with a feature entity within the representation including data defining a region of influence associated with the feature entity;
- (b) calculation means for calculating interest values in respect of at least some of the nodes in dependence upon whether or not they fall within a region of influence; and
- 10 (c) processing means for generating a route along a plurality of nodes in dependence upon the calculated interest values.

31. Apparatus for controlling the field of view of a virtual entity travelling through a virtual environment, the apparatus comprising:

- 15 (a) storage means storing a plurality of data groups, each of which stores data associated with a feature entity within the representation including data defining a region of influence associated with the feature entity; and
- (b) processing means for generating a field of view parameter or set of parameter in respect of the travelling virtual entity which controls the field of view associated with the entity as it travels through the virtual world wherein the field of view parameter or set of parameters
- 20 is generated in a manner which depends upon whether the virtual entity is within or without a region of influence.

32. A method of determining a path along some of a plurality of points in a virtual environment comprising a plurality of initially defined points, and obstructions through which

25 the path cannot pass, and in which two points are said to have line of sight if a straight line link between the two points does not pass through any of the obstructions, the method comprising:

- (a) selecting a start point and an end point for said path in said virtual environment;
- (b) dynamically redefining the topology of the virtual environment in the vicinity of said
- 30 start point and said end point and the region between said start point and said end point by generating a plurality of additional points, wherein said plurality of additional points are generated by repeating the following step:
 - defining a new point located between a first existing point and a second existing
 - point, wherein a first line between the first point and the new point and a second line between
 - 35 the new point and the second point do not pass through any of the obstructions; and
 - (c) calculating the path based on any combination of new and/or initially defined

points, wherein the angle of deviation of the first line to a line between the first and second points is constrained.

33. A method as claimed in claim 32, wherein the constraint is imposed by assigning a
5 varying angle of deviation cost value in dependence on the angle to which the first line deviates from the second line.

34. A method as claimed in any one of claims 38 to 40, wherein the angle of deviation is constrained to a predetermined range.

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35. A method as claimed in claim 41, wherein the range of the angle of deviation is determined as a function of a range of angles within which the first line approaches the new point from the first point, and a predetermine angle of deviation.

15 36. A method as claimed in any one of claims 32 to 35, wherein said method is performed to create the content of the virtual environment.

37. A method as claimed in any one of claims 32 to 36, wherein said method is performed after the content creation of the virtual environment to dynamically determine the
20 path.

38. A method as claimed in any one of claims 32 to 37, wherein said path determined has a dynamically changing destination node.

25 39. A method of generating an automated path along some of a plurality of points in a virtual environment in which the rate of curvature of the path as a function of distance along the path is constrained, the method comprising determining the path in a topology comprising a plurality of initially defined points, and obstructions through which the path cannot pass, and in which two points are said to have line of sight in said topology if a straight line link
30 between the two points does not pass through any of the obstructions, the method comprising:

(a) selecting a start point and an end point for said path in said virtual environment;

(b) dynamically redefining the topology of the virtual environment in the vicinity of said start point and said end point and the region between said start point and said end point by
35 generating a plurality of additional points, wherein said plurality of additional points are generated by repeating the following step:

defining a new point located between a first existing point and a second existing point, wherein a first line between the first point and the new point and a second line between the new point and the second point do not pass through any of the obstructions; and

- (c) calculating the path based on any combination of new and/or initially defined
5 points, wherein the angle of deviation of the first line to a line between the first and second points is constrained.

40. A method as claimed in claim 39, wherein the speed of navigation along the path is determined as a function of the rate at which the degree of curvature of the path changes as
10 a function of distance along the path.

41. A system for determining a path along some of a plurality of points in a representation of an environment, the representation comprising a plurality of initially defined points, and obstructions through which the path cannot pass, the system comprising:

- 15 processing means to define a plurality of additional points by repeatedly defining a new point located between a first existing point and a second existing point, wherein a first line between the first point and the new point and a second line between the new point and the second point do not pass through any of the obstructions; and

processing means to calculate the path based on any combination of new and/or
20 initially defined points, wherein the angle of deviation of the first line to a line between the first and second points is constrained to ensure that the rate at which the curvature of the path varies as a function of position along the path falls within a predetermined range of values.

25 42. A system as claimed in claim 41, wherein the system further comprises means to enable a user to be automatically navigated along said path.

43. A system as claimed in any one of preceding claims 41 or 42, wherein the system further comprises means to enable a user to select rate at which the curvature of the path
30 varies as a function of position along the path.

44. A user interface for a navigational system as claimed in any one of claims 41 to 43, wherein the user interface is arranged to provide said means to enable the user to select the rate at which the curvature of the path varies as a function of position along the path.

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45. A storage medium carrying computer readable code representing instructions for

causing one or more processors to perform the method according to any of claims 1 to 17 or 32 to 40 when the instructions are executed by the processor or processors.

46. A computer program comprising instructions for causing one or more processors to perform the method according to any of claims 1 to 17 or 32 to 40 when the instructions are executed by the processor or processors.

47. A computer data signal embodied in a carrier wave and representing instructions for causing one or more processors to perform the method according to any of claims 1 to 17 or 32 to 40 when the instructions are executed by the processor or processors.

48. A storage medium carrying computer readable code representing instructions for causing one or more processors to operate as the system according to any of claims 18 to 29 or 41 to 43 to when the instructions are executed by the processor or processors.

49. A computer program comprising instructions for causing one or more processors to operate as the system according to any of claims 18 to 29 or 41 to 43 when the instructions are executed by the processor or processors.

50. A computer data signal embodied in a carrier wave and representing instructions for causing one or more processors to operate as the system according to any of claims 18 to 29 or 41 to 43 when the instructions are executed by the processor or processors.